LESSON FROM THE INTERNATIONAL CONFERENCE: THE USE OF ADVANCE TECHNOLOGY IN WOUND CARE

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OUTLINE

- Ultrasound
- Laser tomography
- Device application

reported that temporal muscle thickness can be an indicator of nutritional status

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BMC Geriatrics

RESEARCH ARTICLE Open Access

A change in temporal muscle thickness is correlated with past energy adequacy in bedridden older adults: a prospective cohort study

Yoko Hasegawa[1,2], Mikako Yoshida[3], Aya Sato[4], Yumiko Fujimoto[5], Takeo Minematsu[6,7], Junko Sugama[8] and Hiromi Sanada[1,7*]

(Yoko Hasegawa, Mikako Yoshida, Aya Sato , Yumiko Fujimoto , Takeo Minematsu, Junko Sugama and Hiromi Sanada, 2021)

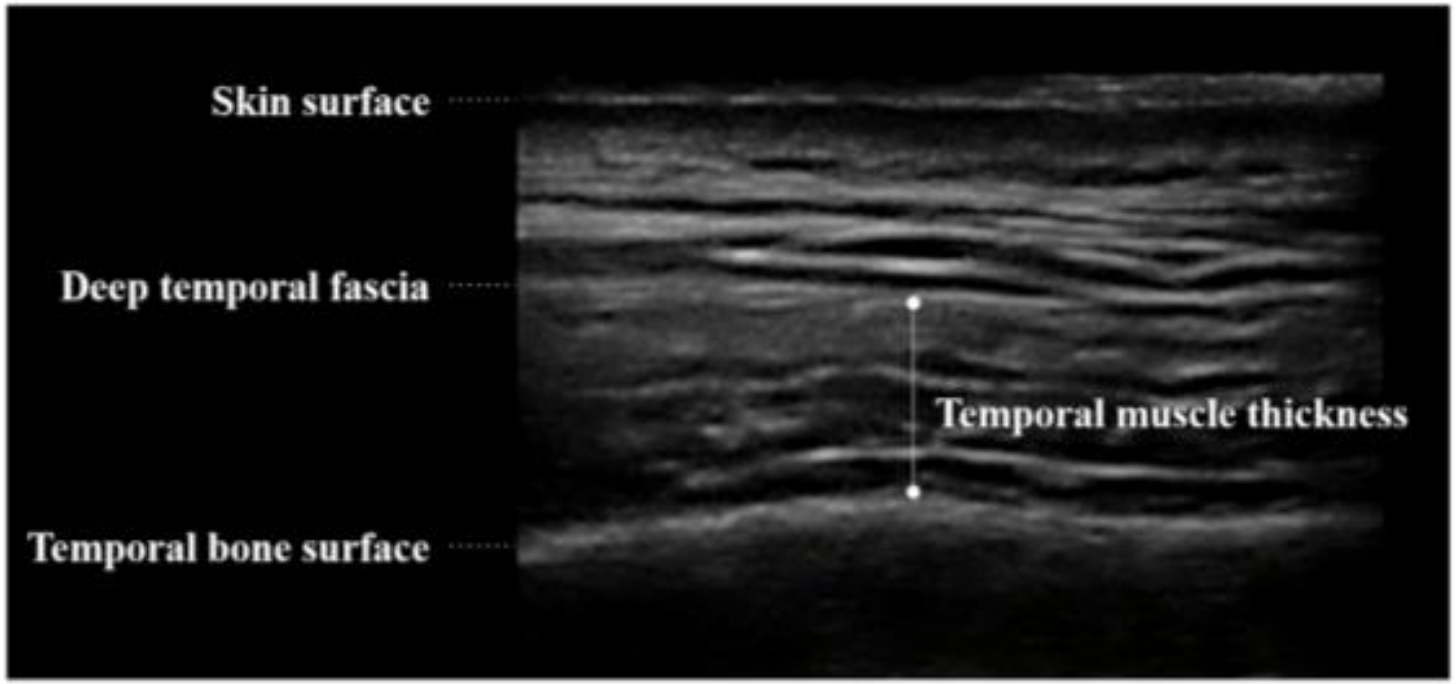

Fig. 1 Ultrasonographic image of temporal muscle. Muscle thickness was defined as the distance between deep temporal fascia to the temporal bone surface. The exact location of measurement was defined upon agreement by three nursing researchers as the highest point in the skull surface in each image

(Yoko Hasegawa, Mikako Yoshida, Aya Sato , Yumiko Fujimoto , Takeo Minematsu, Junko Sugama and Hiromi Sanada, 2021)

Baseline nutritional status		
Serum prealbumin (mg/dL)	16.9 ± 5.8	(3.8 - 28.8)
Body mass index (kg/m^2)	18.9 ± 2.8	(12.9 - 25.1)
Arm circumference (cm)	22.0 ± 3.0	(16.0 - 27.0)
Triceps skinfold thickness (mm)	6.7 ± 5.7	(1.0 - 30.0)
Arm muscle circumference (cm)	19.9 ± 2.4	(15.5 - 26.2)
Calf circumference (cm)	24.6 ± 3.5	(19.3 - 33.8)
Temporal muscle thickness (mm)	3.6 ± 0.9	(2.1 - 5.2)
Estimated BEE (kcal/day)	885 ± 118	(658 - 1240)
Activity factor	1.3 ± 0.2	(0.9 - 1.7)
Stress factor	1.1 ± 0.1	(0.9 - 1.4)
Estimated TEE (kcal/day)	1248 ± 348	(651 - 2163)
(kcal/kg/day)	31 ± 8	(16 - 52)
Energy intake (kcal/day)	1099 ± 294	(387 - 1766)
(kcal/kg/day)	27 ± 8	(11 - 47)
Energy adequacy (%)	92.2 ± 28.1	(28.0 - 142.0)

Data are presented as mean ± SD (range) or number (%). BEE, basal energy expenditure; TEE, total energy expenditure.

(Yoko Hasegawa, Mikako Yoshida, Aya Sato , Yumiko Fujimoto , Takeo Minematsu, Junko Sugama and Hiromi Sanada, 2021)

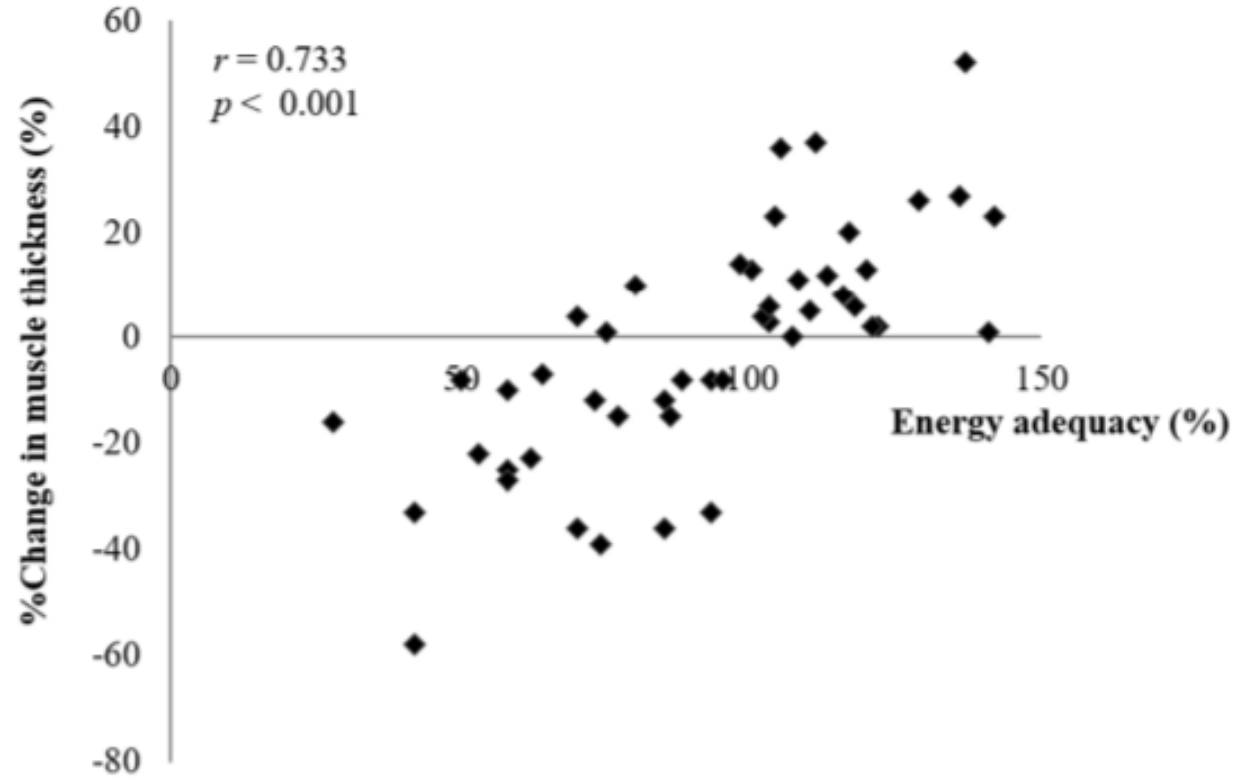

Fig. 2 Correlation of percentage changes in muscle thickness with energy adequacy ($n = 48$). The percentage change in muscle thickness was calculated by dividing a change in temporal muscle thickness over 4 weeks by baseline thickness

(Yoko Hasegawa, Mikako Yoshida, Aya Sato , Yumiko Fujimoto , Takeo Minematsu, Junko Sugama and Hiromi Sanada, 2021)

Table 2 Multiple logistic analysis of factors affecting moderate energy inadequacy (adequacy < 75%)

(*n* = 48)

		COR	*p*	95%CI			AOR	*p*	95%CI		
%Change in temporal muscle thickness (%)		0.364	0.001	0.201	–	0.659	0.281	0.002	0.125	–	0.635
Age		0.999	0.973	0.921	–	1.082	1.003	0.960	0.894	–	1.125
Sex (Female)		1.267	0.710	0.364	–	4.409	6.024	0.118	0.632	–	57.401
Masticatory status	Frequent	Ref					Ref				
	A little	2.250	0.397	0.345	–	14.694	2.033	0.634	0.109	–	37.799
	None	1.167	0.833	0.279	–	4.871	2.164	0.446	0.297	–	15.741

Hosmer-Lemeshow test, $p = 0.552$. Percentage of correct classification, 87.5%
Abbreviations: *COR* crude odds ratio, *AOR* adjusted odds ratio, *CI* confidential interval
Independent variables: age, sex, masticatory status, and percentage change in temporal muscle thickness

(Yoko Hasegawa, Mikako Yoshida, Aya Sato , Yumiko Fujimoto , Takeo Minematsu, Junko Sugama and Hiromi Sanada, 2021)

Nutritional management using ultrasonography of the temporalis for patients with pressure ulcers in a home care setting: A case report.

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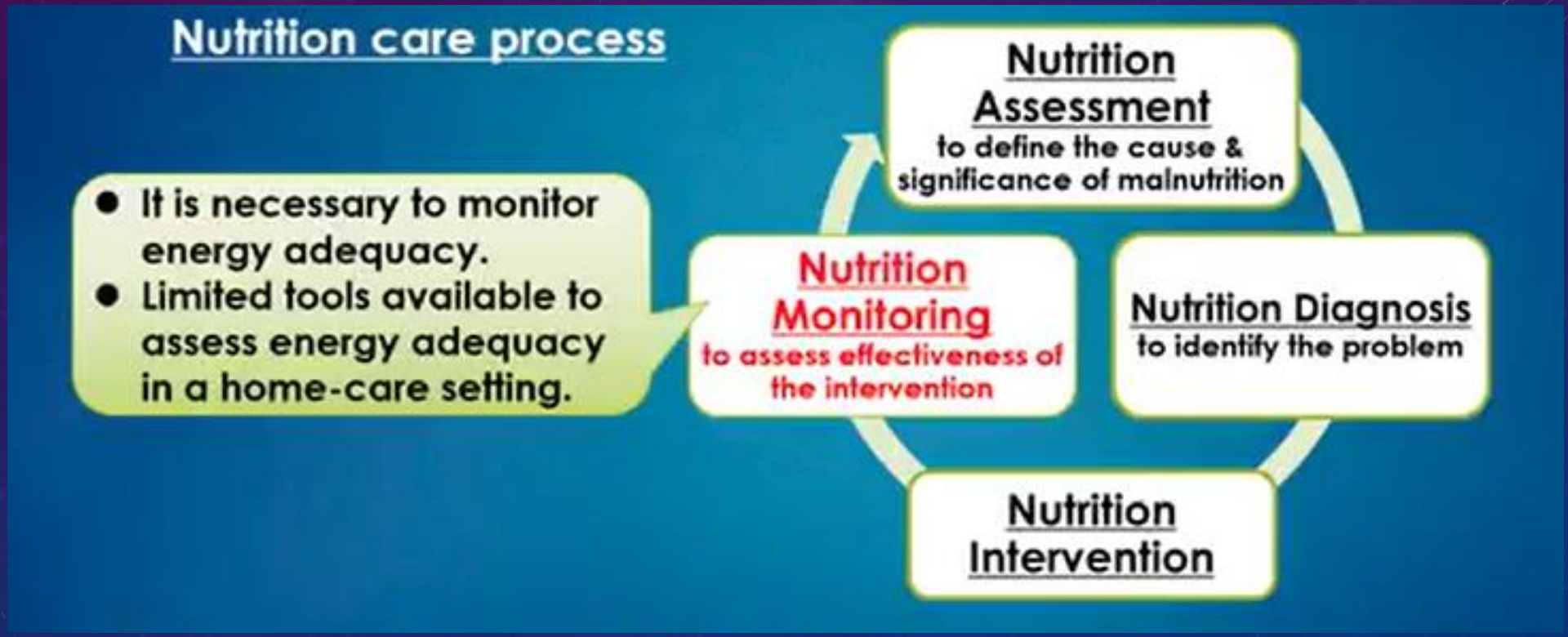
COI Disclosure
Name of First Author : Yoko Hasegawa
The authors have no financial conflicts of interest to disclose concerni

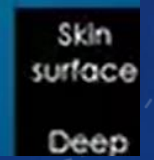
BACKGROUND

- Nutrition intervention for malnutrition is essential for the management of pressure ulcers



TEMPORAL MUSCLE THICKNESS (TMT)

- TMT can be measured by a portable ultrasonography.
  - Reliability: ICC(1,1)=0.99(95% CI: 0.98–1.00); CV 2.3%; no systemic errors. (Hasegawa, 2019)
- TMT is one of the indicators of nutritional status. (Hasegawa, 2019)
- A change in TMT correlates with past energy adequacy in bedridden elderly people independently from masticatory status. (Hasegawa, 2021)



NUTRITION CARE PLAN

- Estimated nutrient requirements

	NPUAP/EPUAP guideline		Pt's requirements	Pt's baseline intake
Energy	30-35 kcal/kg/day	→	1369-1597 kcal/day	1375 kcal/day
Protein	1.25-1.5 g/kg/day	→	57-68 g/day	38 g/day

- Recommended the use of a high-calorie high protein oral nutritional supplement(ONS).

NUTRITION STATUS AND HEALING OF PU

Deteriorate

Improved

Complete closure at Week 12

Case: 90-year-old bedridden female

- **Dx: severe pressure ulcer on the sacrum**
  - Braden scale score: 9 points
  - DESIGN-R® score: 25 points (D4-E6s6I3G6N3)
  - Meditations: Silver sulfadiazine cream
- **Current medical history:**
  - 2014. X. Cognitive function worsen after the flu infection.
  - 2016. X. ADL gradually deteriorated resulting in inability to walk.
  - 2017. X. Became unable to defecate or urinate properly resulting in diaper dermatitis → Became bedridden and developed a pressure ulcer.

DISCUSSION

- ✓ Ultrasonographic evaluation of the temporalis was carried out without any trouble or complain from a patient or caregivers in a home care setting
- ✓ TMT changed more rapidly and evidently than other nutritional parameters such as AC and CC in accordance with nutrition intervention. Also, the increase of TMT seemed to be related to a healing of pressure ulcer
- ✓ The ultrasonographic evaluation of TMT enables a real-time and noninvasive assessment of energy adequacy at patient's bedside, and therefore could be useful for nutritional management for patients with pressure ulcer in a home-care setting

Association between elevated skin temperature at foot callus and inflammatory marker in people with diabetes

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CALLUSES IN PEOPLE WITH DIABETES

Calluses are one of the leading causes of foot ulcers in people with diabetes.(IWGDF, 2019)

Need appropriate callus care

diabetic foot outpatient clinic
at The University of Tokyo Hospital

SKIN TEMPERATURE

Many studies recommended to detect the increased skin surface temperature as an indicator of skin inflammation

- Skin temperature using thermography at one point was effective for early detection of foot ulcers (Armstrong, 2007)
- Monitoring skin temperature was useful for the prevention of deterioration from the callus lead to the ulcer (Oe, 2017)

SKIN TEMPERATURE

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- Monitoring skin temperature was useful for the prevention of deterioration from the callus lead to the ulcer (Oe, 2017)

There is no evidence whether the surface temperature at the callus site of foot plantar represents tissue inflammation.

AIM

To investigate the relationship between inflammation of the callus site using thermography and inflammation using skin blotting in people with diabetes

STUDY METHOD

Study design: cross-sectional observational study

Inclusion criteria:

People >20 years old who have calluses on plantar at diabetic foot outpatient clinic in a university hospital

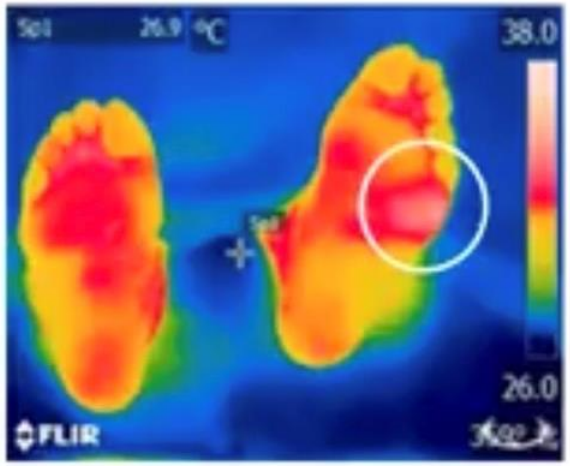
Exclusion criteria:

People who have a foot ulcer during the survey

MAIN VARIABLES

Skin surface temperature

Thermography (CPAT420A; FLIR Systems, Inc, USA)



Callus site

VARIABLES

Callus inflammation

Skin blotting for tumor necrosis factor α (TNFα)

- Technique to measure protein secretion at the skin and subcutaneous levels non-invasively (Minematsu, 2014)
- Wound blotting method noninvasively revealed the TNFα distributions within the wound tissue. (Kitamura, 2014)

←TNFα positive

←TNFα negative（white square）

ASSOCIATION BETWEEN ELEVATED SKIN TEMPERATURE AND CALLUS INFLAMMATION

	Inflammatory marker (+)	Inflammatory marker (−)	Total	p-value
Elevated skin temperature (+)	8	3	11	0.009
Elevated skin temperature (−)	4	15	19	
Total	12	18	30	

Fisher's exact test.

sensitivity: 0.67, specificity: 0.83, positive predictive value: 0.73, negative predictive value: 0.79

NOVELTY

To validate the identification of inflammation due to evaluate skin temperature at the callus site in people with diabetes

Identifying inflammation by thermography provides evidence for early intervention in foot ulcer prevention.

DISCUSSION

Discussion: Interpretation of results

	Inflammatory marker (+)	Inflammatory marker (−)	Total	p-value
Elevated skin temperature (+)	8	3	11	0.009
Elevated skin temperature (−)	4	15	19	
Total	12	18	30	

sensitivity: 0.67, specificity: 0.83, positive predictive value: 0.73,

negative predictive value: 0.79

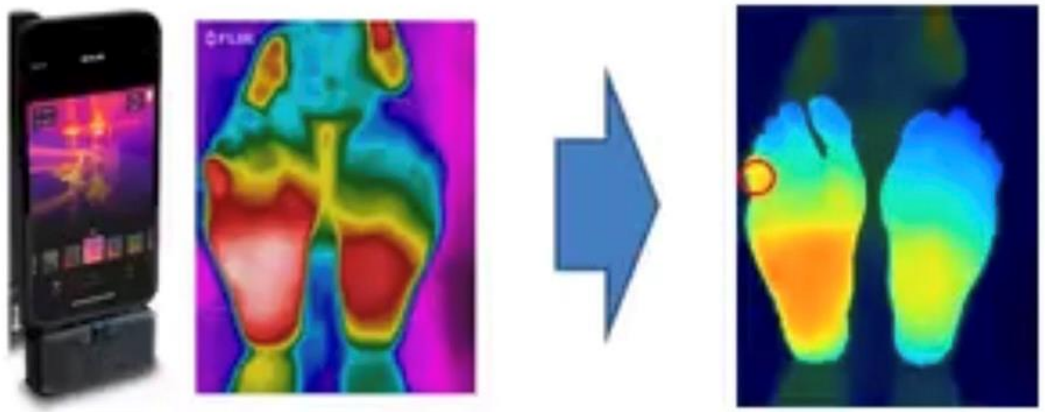
Future callus care

- Removal callus care which temperature has elevated by thermography
- Check frequently
- Real time and visually with the patient

CONCLUSION

- The ratio of TNFα-positive calluses using skin blotting was significantly higher in the callus with an elevated skin temperature by thermography than in the callus without an elevated skin temperature of the callus.
- Our findings suggested that elevated skin temperature in the callus site indicates inflammation.

Automatic detection of locally temperature-elevated area of foot plantar from thermographic image: preliminary trial



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BACKGROUND

Diabetic foot ulcer

- One of the complications of diabetes
- Foot ulcer seriously affects the patient's quality of life and mortality

[Brod M. Qual Life Res. 1998;7(4):365-372]

Detection of the inflammatory symptom on the foot plantar is important

[IWGDF Practical guidelines on the prevention and management of diabetic foot Disease 2019]

Thermography

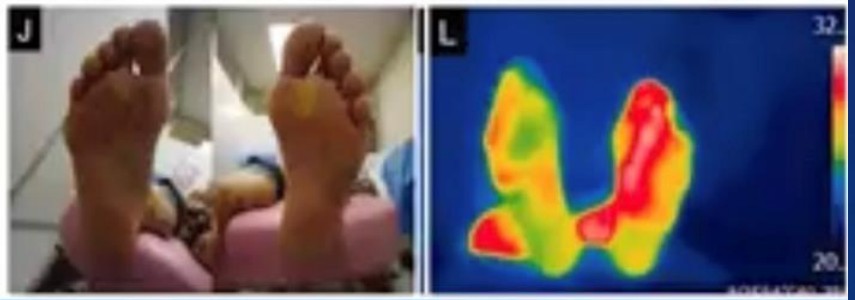
- Direct and immediate detection of abnormal temperature area
- Assessment of inflammatory symptom

[Nishide K. Diabetes research and clinical practice. 2009;85(3):304-309.]

Smart phone with thermography camera (typical device: FLIR-one)

- Reliability and validity was confirmed [Kanazawa T. J Wound Care. 2016;25(4):177-182]
- Case reports using the device for selfcare [Oe M. J Wound Care. 2021;30(2):116-119]

Development of a self-care device for people with diabetes to monitor their feet using the thermography

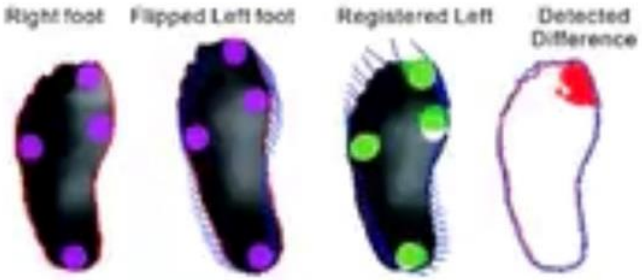


AUTOMATIC DETECTION OF LOCALLY TEMPERATURE-ELEVATED AREA

As a part of the device, automatic detection of locally temperature-elevated area is required to support users' decision

Previous research

Detection of the corresponding position of the left and right feet for asymmetric thermographic pattern detection [Chanjuan Liu, J biomed. optics, 2015;20(2)]



problem The method only registers the left and right feet areas and cannot detect locally temperature-elevated area from thermographic data

A new method is required to detect locally temperature-elevated area

PURPOSE

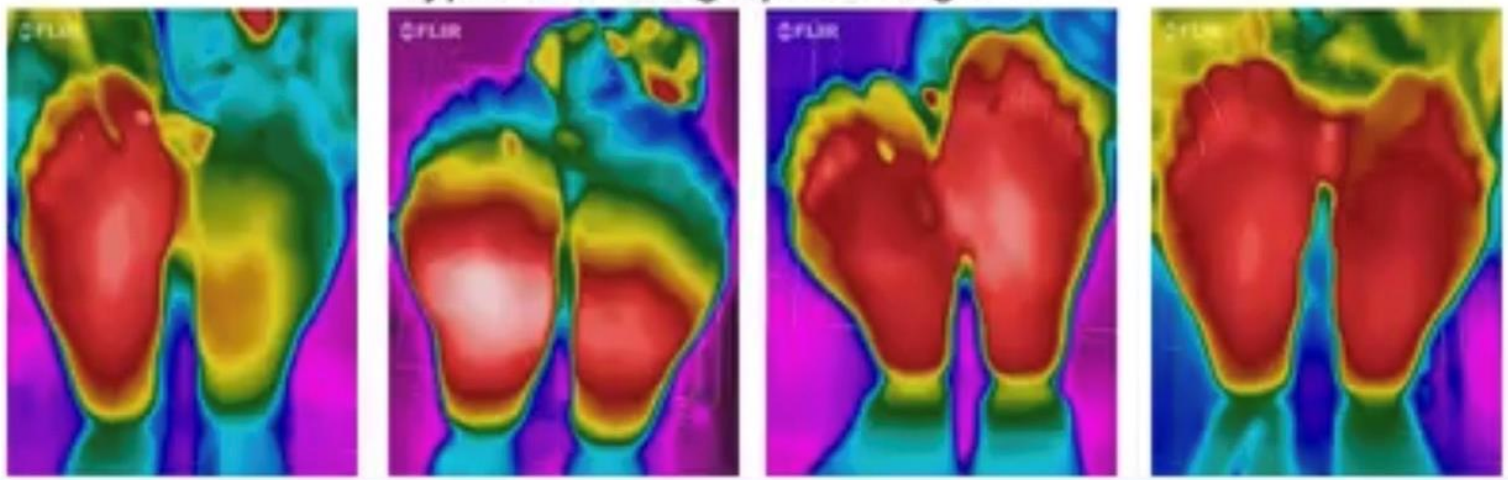
Our research purpose is to develop a new method to detect locally temperature-elevated area from only images captured by smart phone with thermography camera

As a preliminary trial, algorithm performance was evaluated based on small dataset of a healthy adult

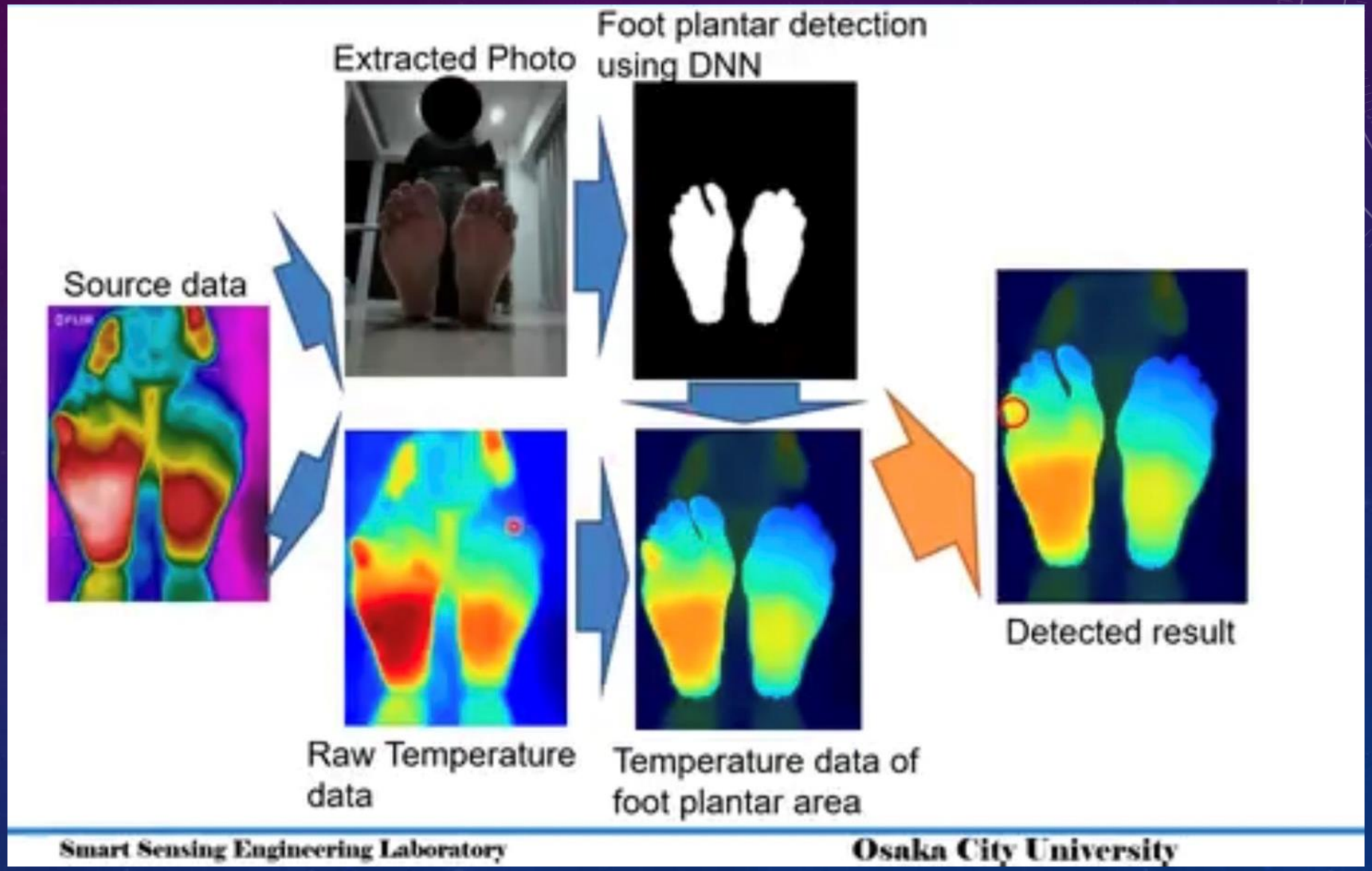
DATASET

- Participant: 40s healthy female
- Duration: Nov-Dec 2020
- Device: FLIR one (Teledyne FLIR LLC, USA)
- Protocol:
  The participant captured her feet by herself using the device every day
- Total number of images : 64
  *Locally temperature-elevated areas were 4.
  These were manually annotated by a researcher

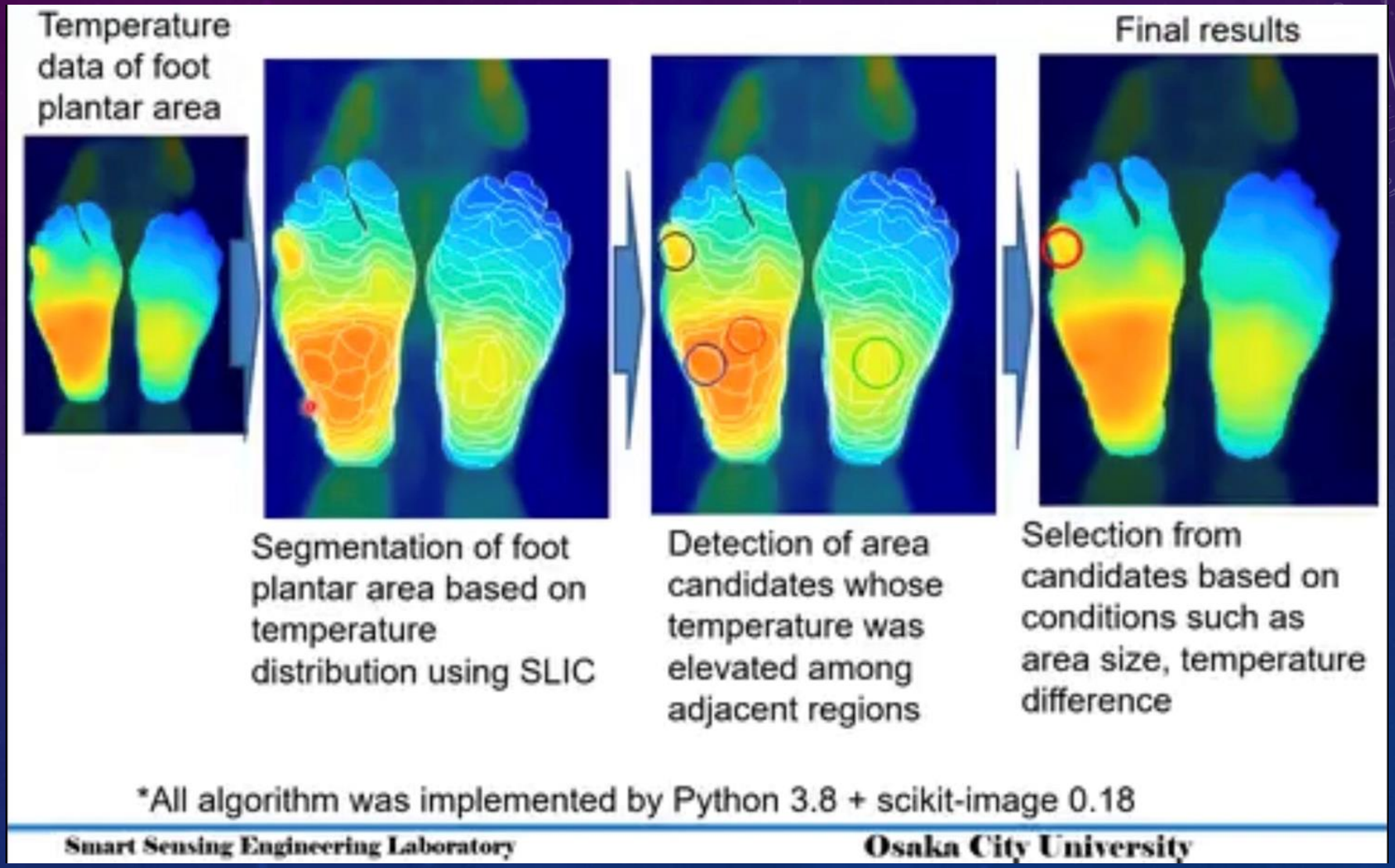
Typical thermographic images



ALGORITHM OVERVIEW



DETECTION ALGORITHM OF LOCALLY TEMPERATURE-ELEVATED AREA

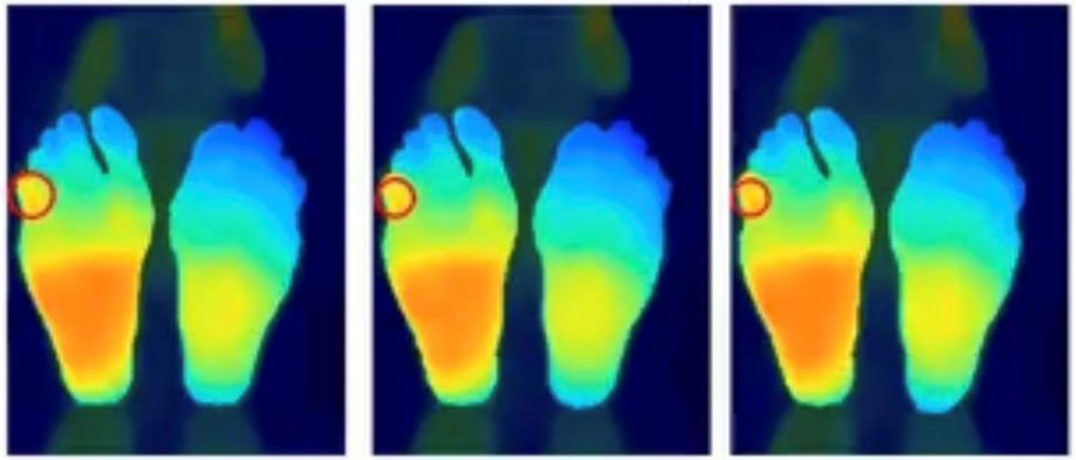


RESULTS

- The algorithm failed to separate foot areas on 3 images among 64 images
- Our algorithm detected 3 locally temperature-elevated area from total 64 images

*The detected area location were matched with human's annotation

Detected area images



Missed image

CONCLUSION

- We propose a new algorithm to detect locally temperature-elevated area on foot plantar from image captured by smart phone with thermography camera
- The preliminary experiment using healthy participant dataset demonstrates our algorithm feasibility

Future Work

- Algorithm improvement: performance, calculation speed and parameter optimization
- Experiment using new dataset including locally temperature-elevated area capture from people with diabetes
- Application development based on the algorithm

Application Example for Skin-tear

System to visualize the 3D Foot Plantar Model with temperature using RGB-D and Thermography Cameras for Prevention of Diabetic Foot Ulcer

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* Department of Electric information, School of Engineering, Osaka City University

INTRODUCTION

- One of the complications of diabetes mellitus is foot ulcer, and diabetic foot ulcer is a serious problem because it is known to lead to amputation of the lower limbs in severe cases.
- Callus, one of factors leading to foot ulcer, with inflammation is a high risk of foot ulcer because the inflammation sometimes indicates troubles under the callus[1].

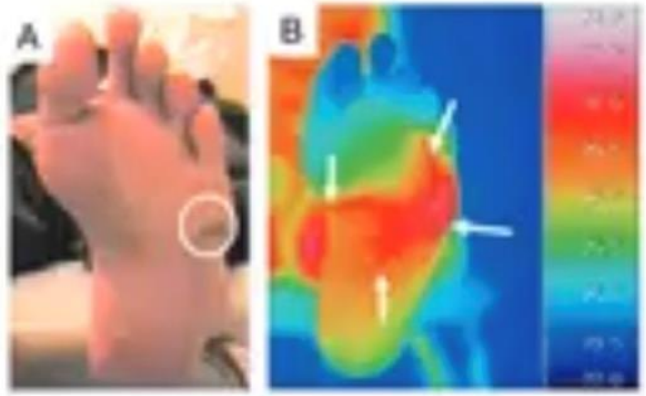
It is very important to detect this inflammation in the early stage.

However, sometimes high-risk area identification itself is difficult because the inflammation occur not only just under callus but also other areas.

[1] International Working Group on the Diabetic Foot (2019) IWGDF Practical guidelines on the prevention and management of diabetic foot disease, https://iwgdfguidelines.org/wp-content/ uploads/2021/03/IWGDF-2019-final.pdf

INTRODUCTION

- As a tool for early detection, thermography cameras have been attracting attention.
- But it is difficult for medical staff members who are not used to judging thermal images to make decisions based on the images.
- In addition to assessment of inflammation signs, there are several factors related to diabetic foot ulcer such as the condition of the callus and foot deformity.



Example of a thermal image of the foot plantar of a diabetic patient

(https://www.jstage.jst.go.jp/article/footcare/16/1/16_37/_pdf/-char/ja)

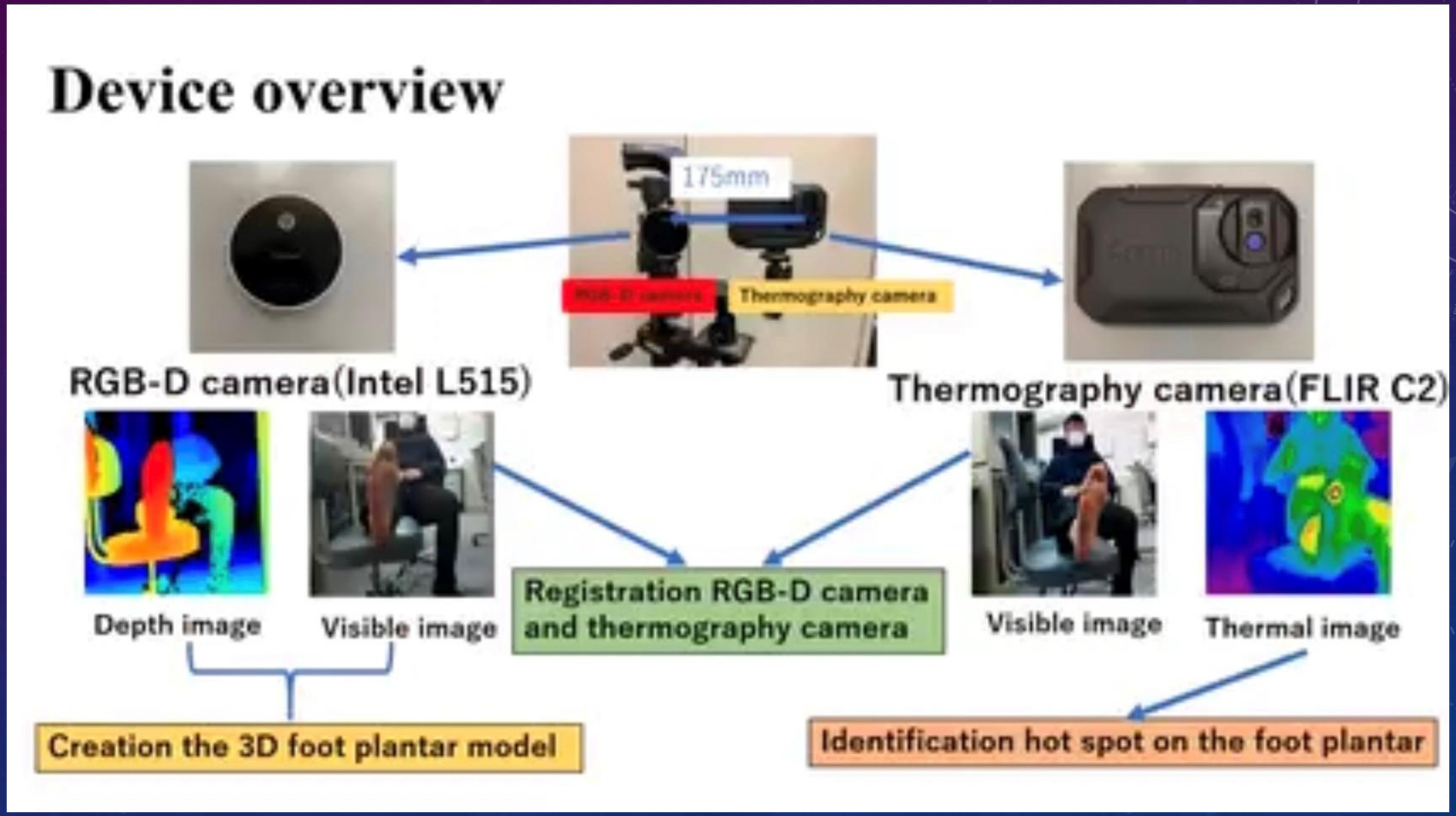
Developing an assessment system that uses 3D information and temperature information is necessary.

PURPOSE

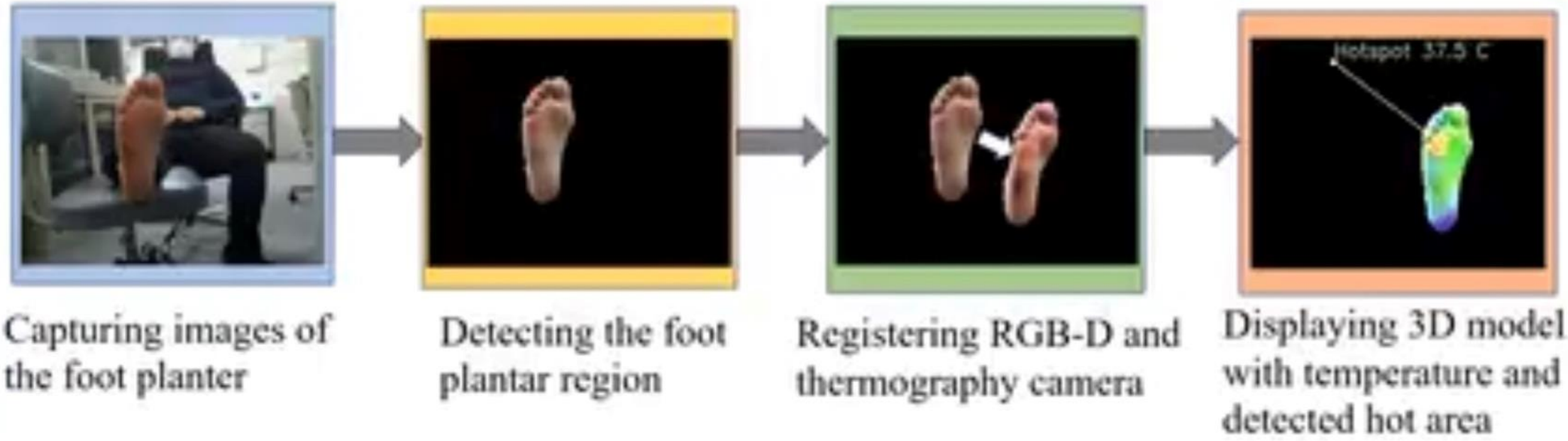
The purpose of this research is to construct a new system to visualize 3D model with temperature using both RGB-D camera and thermography camera.

As an example of application using the system, visualization of 3D thermographic model and hot spot area is also constructed.

DEVICE OVERVIEW

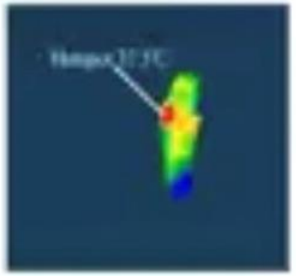


ALGORITHM OVERVIEW



CONCLUSION

- We developed a system to visualize 3D data with temperature using RGB-D and thermography cameras for prevention of diabetic foot ulcers.
- Feasibility experiment demonstrated the availability of the system.



Future tasks：

- In this study, only the maximum temperature was detected, but we plan to develop a method that can detect the temperature-elevated area.

- In addition, we also try to develop a method that can detect the foot plantar deformation.

Device application

Wound Care Devices, Apps, Integrations, and Analytics: A Digital Health Platform Overview for Industry and Clinicians

Printer-friendly version

Submitted by Tissue Analytics on November 20th, 2018

1. Advanced sensors and imaging devices
2. Mobile measurement apps
3. EMR connectivity and integrations
4. Data analytics and predictive modelling

(Rafael Mazuz, 2018)

Effectiveness of teleconsultations with Wound, Ostomy, and Continence Nurses on pressure injury healing in community settings

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Health insurance system for patients with pressure injuries in Japan

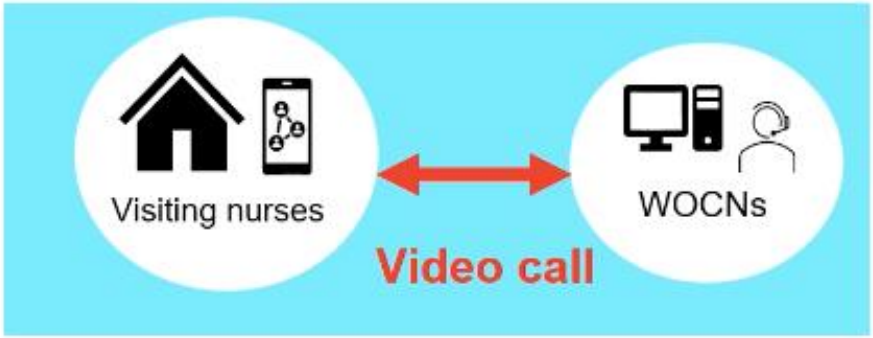
"Visiting nursing and guidance fee 3"

- When a visiting nurse and a hospital-based Wound, Ostomy, and Continence Nurse (WOCN) visit home care patients with pressure injuries (PIs), the cost will be covered by healthcare insurance.

Challenges

- Difficult for WOCNs to visit the patients due to scheduling and transportation issues.
- Less than 5% of patients receive this service.

A need for simultaneous hands-on wound care with real-time, remote consultation.



Development of an application for synchronous access to remote consulting nurses

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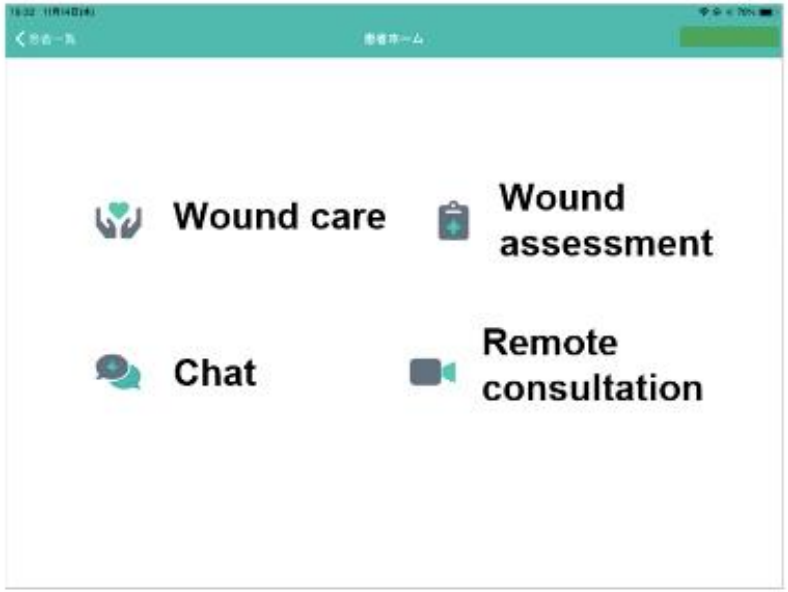
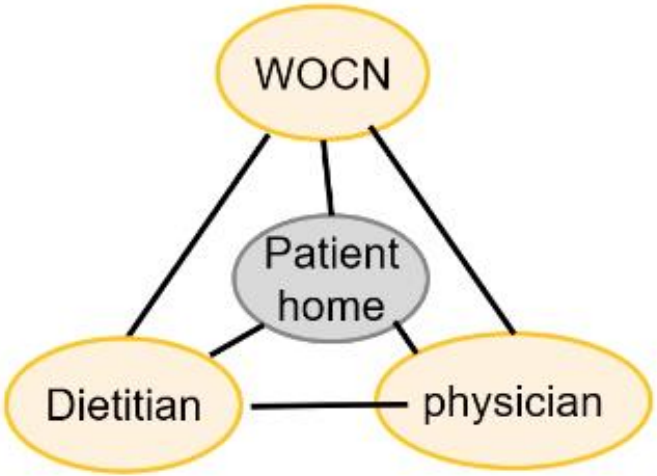
CARES4WOUNDS



Videophone

Interdisciplinary cooperation



Aims

To examine

- the effectiveness of teleconsultations with WOCNs on PI healing in community settings
- consultation time
- costs for a WOCN for the first consultation

Methods: Study design and eligibility

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DESIGN: A pre-post study

Inclusion criteria:

- Patients with D3 or more severe (full-thickness) PIs
- Patients receiving PI care from visiting nurses for at least 2 weeks

Exclusion criteria:

- Patients under 20 years old
- Patients who had died, became hospitalized, or stopped receiving visiting nursing services before the first video consultations
- PIs which were d2 (superficial) or healed at the first video consultation

Methods: Intervention

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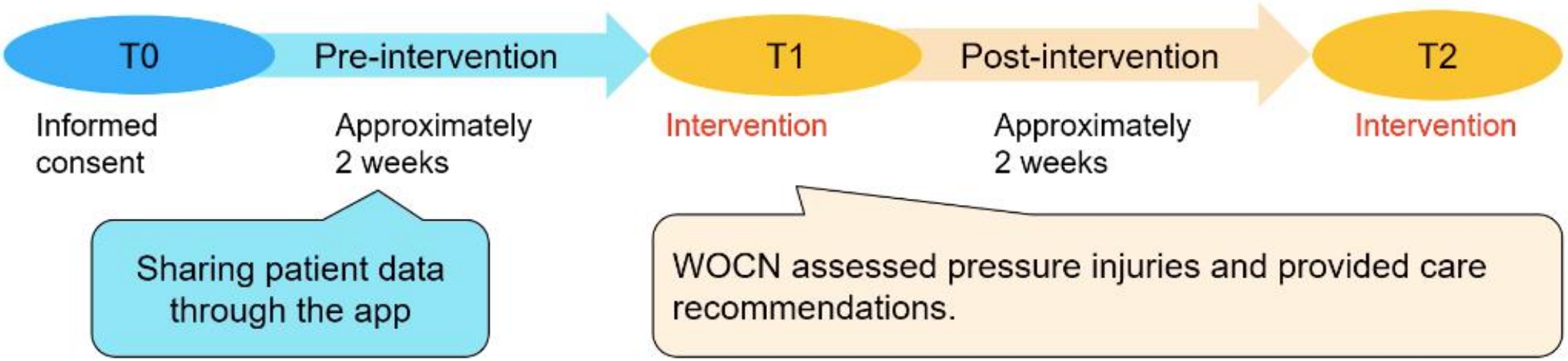
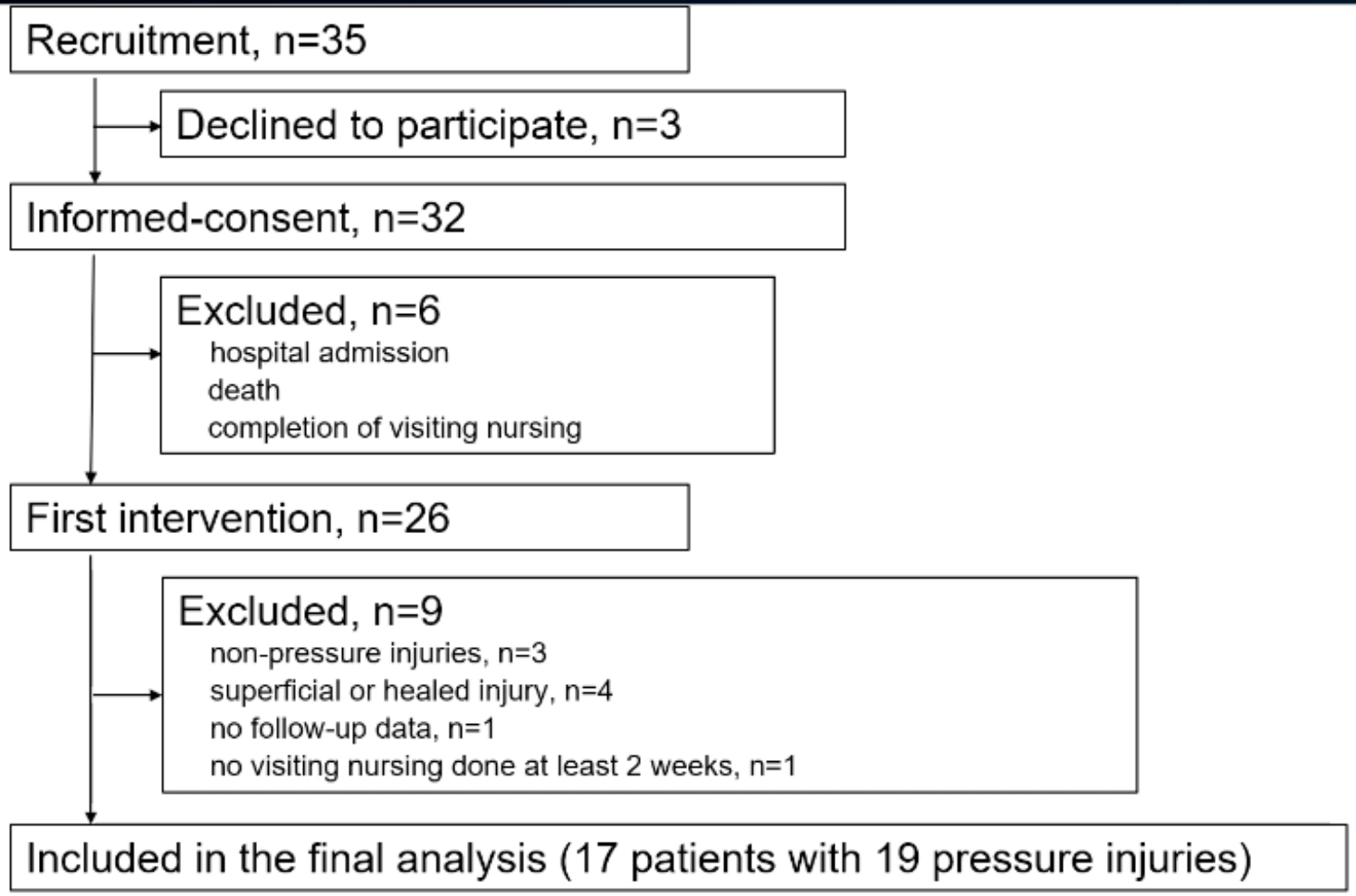
Intervention: remote, real-time consultation at home with a WOCN



Outcomes: DESIGN-R total score
Consultation time
Costs for WOCN at first consultation (Labor costs and costs for wireless data)

Results: Patient flow



Results:
Characteristics of patients and pressure injuries

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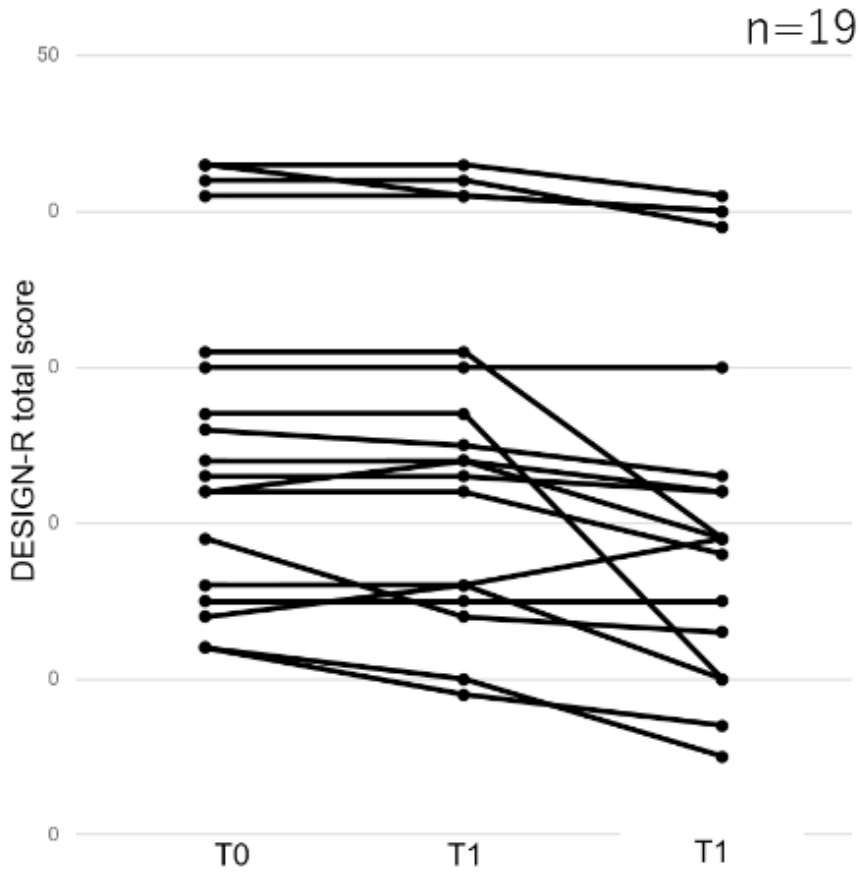
Patients (n=17)

	Median (IQR) or n (%)
Age	85 (74-91)
Sex Women	12 (70.6)

Pressure injuries (n=19)

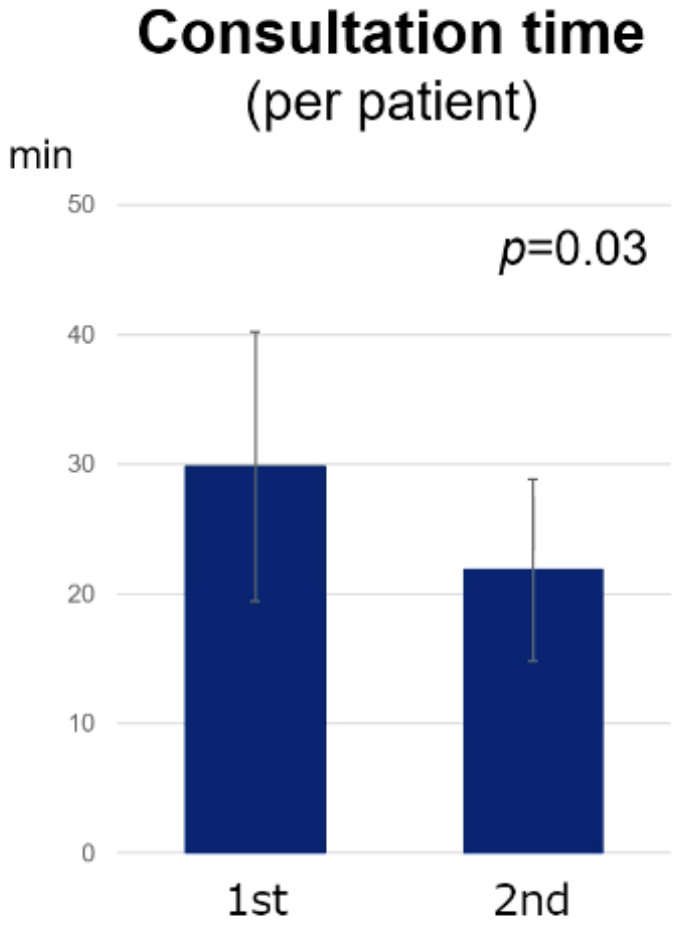
		n (%)
Location	Sacrum	6 (33.3)
	Coccyx	4 (21.1)
	Ankle	3 (16.7)
	Fibula	2 (11.1)
	Others	3 (16.7)
Depth (DESIGN-R)	D3	9 (47.4)
	D4	10 (52.6)
History of wounds	3 months or more	15 (83.3)

Results: Changes in DESIGN-R total score



	Pre	Post	*p*
Changes in DESIGN-R score	0 (-1 – 0)	-2 (-5 – -1)	0.02

Results: Consultation time and costs



Costs by WOCN for the first consultations

Items	Costs
Labor	2,201.7±641.8
Wireless data (0.5GB)	100
Total	2,301.7±641.8

Discussion

Originality

- This is the first study to show the effectiveness of remote, real-time consultations by a WOCN, in collaboration with visiting nurses, for patients with PIs in Japanese community settings.

The app has key functionality for effective remote consultations.

Costs

- WOCN first consultation fees: approximately 2,300 yen
- Second consultations were shorter than first consultations
- Time to explain the app to visiting nurses is not needed for second consultations
- Fee for use of the app (in Singapore, approximately 700 yen/day)

The costs can be covered by “Visiting nursing and guidance fee 3” (12,850 yen)

Conclusion

- Remote real-time consultations by a WOCN, in collaboration with visiting nurses, for patients with PIs can contribute to PI healing in Japanese community settings.
- The costs can be covered by “Visiting nursing and guidance fee 3”.


A great big
THANK YOU